CLAIMS

WE CLAIM:

1. A wireless sensor communication module for operating in an ad-hoc sensor network having a plurality of nodes, the module comprising:

a controller configured to receive power capability data representative of power capability of other wireless sensor communication modules in the sensor network and operable, in response thereto, to (i) determine a data transmission route through the sensor network based at least in part on the power capability data and (ii) supply transmission route data representative thereof; and

a transceiver configured to receive sensor data and operable to modulate the sensor data with a radio frequency (RF) signal to thereby generate RF modulated sensor data, the transceiver additionally coupled to receive the transmission route data and operable, in response thereto, to transmit the RF modulated sensor data to a sensor network node in the determined transmission route.

2. The module of Claim 1, wherein the sensor network node in the determined transmission route is one of the other wireless sensor communication modules in the sensor network.

3. The module of Claim 1, wherein the transceiver is further configured to receive RF modulated sensor data from one or more of the other sensor communications modules in the sensor network and is operable, in response thereto, to retransmit the received RF modulated sensor data.

4. The module of Claim 3, wherein the transceiver retransmits the received RF modulated sensor data to a sensor network node in a transmission route determined by one of the other sensor communications modules.

5. The module of Claim 1, wherein:

the controller is further coupled to receive position data representative of a position of one or more of the other communications modules in the sensor network; and

the controller is further operable to determine the data transmission route through the sensor network based at least in part on the power capability data and the position data.

6. The module of Claim 5, wherein:

the transceiver is configured to receive RF modulated position data from one or more of the other communications modules in the sensor network and operable to demodulate the position data therefrom; and

the controller is coupled to receive the demodulated position data from the transceiver.

7. The module of Claim 1, wherein:

the controller is further operable to supply position data representative of its position in the sensor network; and

the transceiver is coupled to receive the position data and is further operable to (i) RF modulate the position data and (ii) transmit the RF modulated position data.

8. The module of Claim 1, wherein:

the controller is further operable to supply identification data that uniquely identifies the module; and

the transceiver is coupled to receive the identification data and is further operable to (i) RF modulate the identification data and (ii) transmit the RF modulated identification data.

9. The module of Claim 8, wherein:

the module is configured to be a member of multiple sensor networks; and

the identification data further identifies the sensor network of which the module is a member.

10. The module of Claim 8, wherein:

the transceiver is configured to receive RF modulated identification data from one or more of the other communications modules in the sensor network and operable to demodulate the identification data therefrom; and

the controller is coupled to receive the demodulated identification data from the transceiver and operable, in response thereto, to determine if the other communication modules are members of the sensor network.

11. The module of Claim 10, wherein:

the transceiver is further configured to receive RF modulated sensor data from one or more of the other sensor communications modules in the sensor network;

the controller is further responsive to the demodulated identification data to issue a retransmission command if it determines that the received RF modulated sensor data was transmitted from a communication module that is a member of the sensor network; and

the transceiver is further coupled to receive the retransmission command and operable, upon receipt thereof, to retransmit the received RF modulated sensor data.

12. The module of Claim 1, wherein the controller is further coupled to receive identification data representative of a unique identifier associated with one or more of the other communications modules in the sensor network and operable, in response thereto, to determine whether the one or more other communication modules are members of the sensor network.

13. The module of Claim 1, wherein the controller is:

further configured to couple to a sensor and receive a sensor signal therefrom; and

further operable to supply the sensor data to the transceiver.

14. The module of Claim 1, wherein:

the controller is further operable to issue a transmission command in accordance with a predetermined schedule; and

the transceiver is coupled to receive the transmission command and operable, upon receipt thereof, to transmit the RF modulated sensor data to the sensor network node in the determined transmission route.

15. The module of Claim 14, wherein:

the predetermined schedule includes a predetermined access time; and

the controller is further operable to issue a predetermined number of transmission commands during the predetermined access time.

16. The module if Claim 15, wherein the controller is further operable to place the module in a sleep mode if the transceiver fails to transmit the RF modulated sensor data after the predetermined number of transmission commands are issued.

17. The module of Claim 1, further comprising:

a power supply coupled to the transceiver and the controller and operable to supply power thereto.

18. The module of Claim 17, wherein the power supply comprises an energy converter configured to convert mechanical energy to electrical energy.

19. The module of Claim 18, wherein the energy converter includes at least a micro electro mechanical generator.

20. The module of Claim 17, wherein the power supply comprises a thermoelectric generator.

21. The module of Claim 1, wherein the sensor network node includes an aircraft engine controller.

22. The module of Claim 1, wherein the wireless sensor communication module is formed as a single integrated circuit using silicon on insulator (SOI) technology.

23. The module of Claim 1, wherein the transceiver is configured to implement at least Frequency Hopping Spread Spectrum (FHSS) radio transmission.

24. A wireless sensor communication module for operating in an ad-hoc sensor network having a plurality of nodes, the module comprising:

a sensor operable to sense a physical parameter and supply sensor data representative thereof;

a controller configured to receive power capability data representative of power capability of other wireless sensor communication modules in the sensor network and operable, in response thereto, to (i) determine a data transmission route through the sensor network based at least in part on the power capability data and (ii) supply transmission route data representative thereof; and

a transceiver configured to receive the sensor data and operable to modulate the sensor data with a radio frequency (RF) signal to thereby generate RF modulated sensor data, the transceiver additionally coupled to receive the transmission route data and operable, in response thereto, to transmit the RF modulated sensor data to a sensor network node in the determined transmission route.

25. The module of Claim 24, wherein the sensor network node in the determined transmission route is one of the other wireless sensor communication modules in the sensor network.

26. The module of Claim 24, wherein the transceiver is further configured to receive RF modulated sensor data from one or more of the other sensor communications modules in the sensor network and is operable, in response thereto, to retransmit the received RF modulated sensor data.

27. The module of Claim 26, wherein the transceiver retransmits the received RF modulated sensor data to a sensor network node in a transmission route determined by one of the other sensor communications modules.

28. The module of Claim 24, wherein:

the controller is further coupled to receive position data representative of a position of one or more of the other communications modules in the sensor network; and

the controller is further operable to determine the data transmission route through the sensor network based at least in part on the power capability data and the position data.

29. The module of Claim 28, wherein:

the transceiver is configured to receive RF modulated position data from one or more of the other communications modules in the sensor network and operable to demodulate the position data therefrom; and

the controller is coupled to receive the demodulated position data from the transceiver.

30. The module of Claim 24, wherein:

the controller is further operable to supply position data representative of its position in the sensor network; and

the transceiver is coupled to receive the position data and is further operable to (i) RF modulate the position data and (ii) transmit the RF modulated position data.

31. The module of Claim 24, wherein:

the controller is further operable to supply identification data that uniquely identifies the module; and

the transceiver is coupled to receive the identification data and is further operable to (i) RF modulate the identification data and (ii) transmit the RF modulated identification data.

32. The module of Claim 31, wherein:

the module is configured to be a member of multiple sensor networks; and

the identification data further identifies the sensor network of which the module is a member.

33. The module of Claim 31, wherein:

the transceiver is configured to receive RF modulated identification data from one or more of the other communications modules in the sensor network and operable to demodulate the identification data therefrom; and

the controller is coupled to receive the demodulated identification data from the transceiver and operable, in response thereto, to determine if the other communication modules are members of the sensor network.

34. The module of Claim 33, wherein:

the transceiver is further configured to receive RF modulated sensor data from one or more of the other sensor communications modules in the sensor network;

the controller is further responsive to the demodulated identification data to issue a retransmission command if it determines that the received RF modulated sensor data was transmitted from a communication module that is a member of the sensor network; and

the transceiver is further coupled to receive the retransmission command and operable, upon receipt thereof, to retransmit the received RF modulated sensor data.

35. The module of Claim 24, wherein the controller is further coupled to receive identification data representative of a unique identifier associated with one or more of the other communications modules in the sensor network and operable, in response thereto, to determine whether the one or more other communication modules are members of the sensor network.

36. The module of Claim 24, wherein the controller is:

further configured to couple to a sensor and receive a sensor signal therefrom; and

further operable to supply the sensor data to the transceiver.

37. The module of Claim 24, wherein:

the controller is further operable to issue a transmission command in accordance with a predetermined schedule; and

the transceiver is coupled to receive the transmission command and operable, upon receipt thereof, to transmit the RF modulated sensor data to the sensor network node in the determined transmission route.

38. The module of Claim 37, wherein:

the predetermined schedule includes a predetermined access time; and

the controller is further operable to issue a predetermined number of transmission commands during the predetermined access time.

39. The module if Claim 38, wherein the controller is further operable to place the module in a sleep mode if the transceiver fails to transmit the RF modulated sensor data after the predetermined number of transmission commands are issued.

40. The module of Claim 24, further comprising:

a power supply coupled to the transceiver and the controller and operable to supply power thereto.

41. The module of Claim 40, wherein the power supply comprises an energy converter configured to convert mechanical energy to electrical energy.

42. The module of Claim 41, wherein the energy converter includes at least a micro electro mechanical generator.

43. The module of Claim 40, wherein the power supply comprises a thermoelectric generator.

44. The module of Claim 24, wherein the sensor network node includes an aircraft engine controller.

45. The module of Claim 24, wherein the wireless sensor communication module is formed as a single integrated circuit using silicon on insulator (SOI) technology.

46. The module of Claim 24, wherein the transceiver is configured to implement at least Frequency Hopping Spread Spectrum (FHSS) radio transmission.

47. An ad-hoc sensor communication network, comprising:

a plurality of wireless sensor communication modules, each communication module in operable communication with one or more other wireless sensor communication modules in the ad-hoc sensor communication network, each wireless sensor communication module comprising:

a sensor operable to sense a physical parameter and supply sensor data representative thereof,

a controller configured to receive power capability data representative of power capability of other wireless sensor communication modules in the sensor network and operable, in response thereto, to (i) determine a data transmission route through the sensor network based at least in part on the power capability data and (ii) supply transmission route data representative thereof, and

a transceiver configured to receive the sensor data and operable to modulate the sensor data with a radio frequency (RF) signal to thereby generate RF modulated sensor data, the transceiver additionally coupled to receive the transmission route data and operable, in response thereto, to transmit the RF modulated sensor data to a sensor network node in the determined transmission route.

48. An ad-hoc aircraft engine sensor communication network, comprising:

a plurality of wireless sensor communication modules, each communication module in operable communication with one or more other wireless sensor communication modules in the ad-hoc aircraft engine sensor communication network, each wireless sensor communication module comprising:

a sensor configured to couple to an aircraft engine and operable to sense a physical parameter associated with the aircraft engine and supply sensor data representative thereof,

a module controller configured to receive power capability data representative of power capability of other wireless sensor communication modules in the aircraft engine sensor network and operable, in response thereto, to (i) determine a data transmission route through the aircraft engine sensor network based at least in part on the power capability data and (ii) supply transmission route data representative thereof, and

a transceiver configured to receive the sensor data and operable to modulate the sensor data with a radio frequency (RF) signal to thereby generate RF modulated sensor data, the transceiver additionally coupled to receive the transmission route data and operable, in response thereto, to transmit the RF modulated sensor data to a network node in the determined transmission route.

49. A method of transmitting sensor data in an ad-hoc wireless sensor network having a plurality of nodes, each node having a power capability associated therewith, the method comprising the steps of:

determining the power capability of at least a portion of the other nodes in the sensor network;

determining a data transmission route through the wireless sensor network based at least in part on the determined power capability;

radio frequency (RF) modulating sensor data to thereby generate RF modulated sensor data; and

transmitting the RF modulated sensor data to a node in the determined data transmission route.

50. The method of Claim 49, further comprising:

receiving RF modulated sensor data from one or more of the other nodes in the sensor network; and

retransmitting the received RF modulated sensor data.

51. The method of Claim 50, wherein the received RF modulated sensor data is retransmitted to a node in a transmission route determined by one of the other nodes in the network.

52. The method of Claim 49, further comprising:

receiving position data representative of a position of one or more of the other nodes in the sensor network; and

determining the data transmission route through the sensor network based at least in part on the power capability data and the position data.

53. The method of Claim 52, further comprising:

receiving RF modulated position data from one or more of the other nodes in the sensor network; and

demodulating the position data therefrom.

54. The method of Claim 49, further comprising each node transmitting RF modulated position data representative of a position of the node in the sensor network

55. The method of Claim 54, further comprising each node transmitting unique RF modulated identification data.

56. The method of Claim 55, wherein:

one or more of the nodes is configured to be a member of multiple sensor networks; and

the RF modulated identification data further identifies the sensor network of which the node is a member.

57. The method of Claim 55, further comprising:

receiving RF modulated identification data from one or more of the other nodes in the sensor network;

demodulating the identification data therefrom; and

determining if the other nodes are members of the sensor network.

58. The method of Claim 57, further comprising:

receiving RF modulated sensor data from one or more of the other nodes in the sensor network; and

retransmitting the received RF modulated sensor data if it is determined that the received RF modulated sensor data was transmitted from a node that is a member of the sensor network.

59. The method of Claim 43, further comprising:

transmitting the RF modulated sensor data in accordance with a predetermined schedule.

60. A method of monitoring a plurality of physical parameters in an aircraft gas turbine engine, the method comprising the steps of:

sensing a plurality of physical parameters in the engine using a plurality of wireless sensors each having a power capability to thereby generate sensor data;

determining the power capability of each of the wireless sensors;

determining a data transmission route from each of the wireless sensors based at least in part on the determined power capability;

radio frequency (RF) modulating the sensor data to thereby generate RF modulated sensor data; and

transmitting the RF modulated sensor data from each of the wireless sensors via the determined data transmission routes.